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FLATHEAD BASIN FOREST PRACTICES
WATER QUALITY AND FISHERIES
COOPERATIVE PROGRAM

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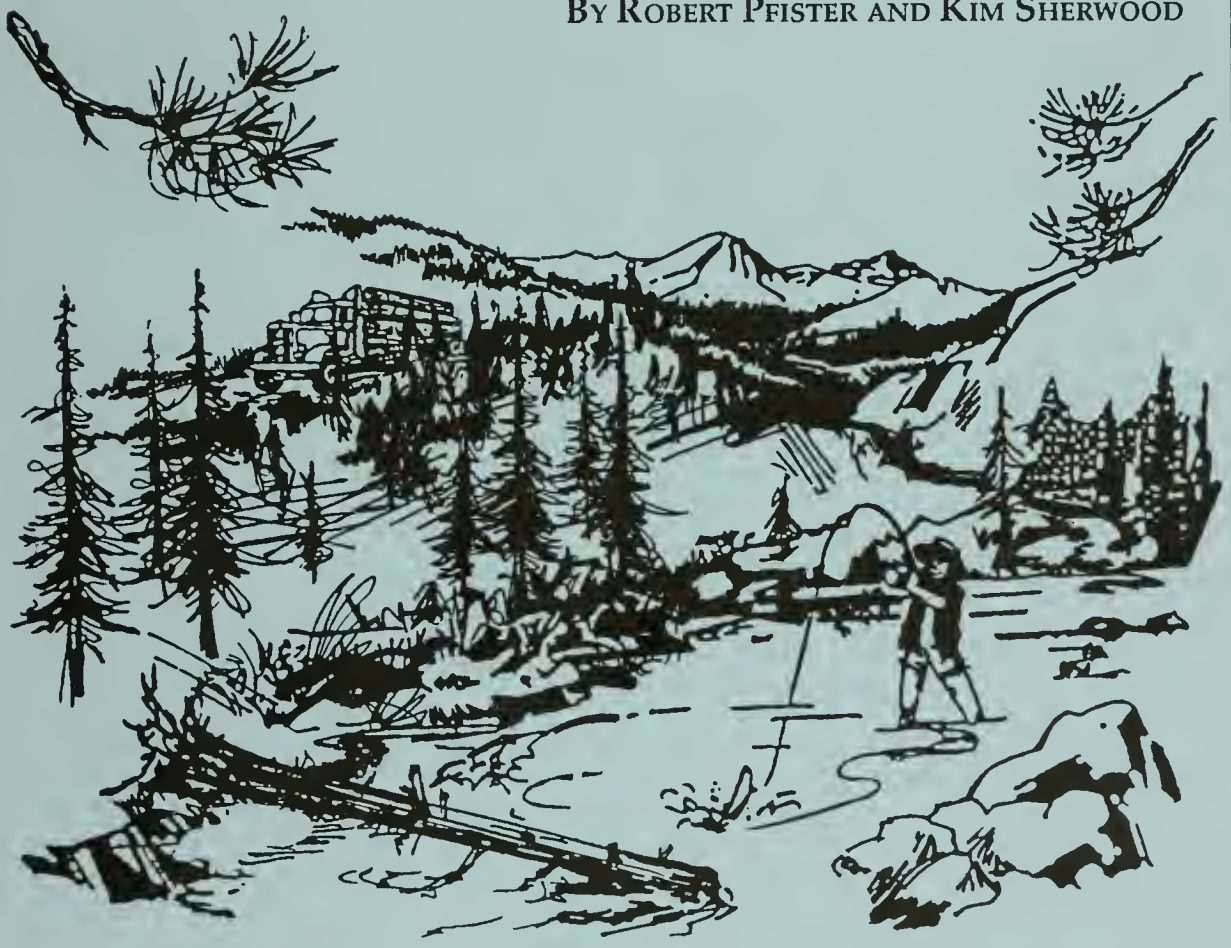
MANAGEMENT GUIDELINES FOR RIPARIAN FORESTS

BY ROBERT PFISTER AND KIM SHERWOOD



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About This Report

This report is one of ten individual studies conducted for the Flathead Basin Forest Practices/ Water Quality and Fisheries Cooperative Program. The Cooperative Program was administered by a Coordinating Team representing the Montana Department of State Lands Forestry Division, the Flathead National Forest, Plum Creek Timber Company, L.P., the Montana Department of Fish, Wildlife and Parks, the Montana Department of Health and Environmental Sciences' Water Quality Bureau, the University of Montana, and the Flathead Basin Commission.

The Cooperative Program's specific objectives were (1) to document, evaluate, and monitor whether forest practices affect water quality and fisheries within the Flathead Basin, and (2) if detrimental impacts exist, to establish a process to utilize this information to develop criteria and administrative procedures for protecting water quality and fisheries.

The ten individual studies included the evaluation of: (1) specific practices at the site level, (2) accumulation of practices at the watershed level, (3) general stream conditions, (4) water quality variables relative to levels of management activity in small watersheds, (5) fish habitat and abundance relative to stream variables influenced by forest practices at the watershed level, (6) long-term changes in large-stream dynamics related to historical records of natural and man-related disturbances, and (7) changes in lake sediments relative to historical records of natural and man-related disturbances. A *Final Report* was developed which contains summaries of each of the studies, a set of summary conclusions and recommendations, and a formal response to the recommendations by the land management organizations which administered the Cooperative Program.

Contributors

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University of Montana
- Flathead Lake Biological Station
- School of Forestry
- Montana Forest and Conservation Experiment Station
- U.S. Department of Agriculture—McIntire-Stennis Program

Montana Department of Fish, Wildlife and Parks
Flathead Basin Commission
Montana Environmental Quality Council
Montana Chapter of the American Fisheries Society
Governor's Office, State of Montana

FLATHEAD BASIN FOREST PRACTICES
WATER QUALITY AND FISHERIES
COOPERATIVE PROGRAM

MANAGEMENT GUIDELINES FOR RIPARIAN FORESTS

BY ROBERT PFISTER AND KIM SHERWOOD

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MANAGEMENT GUIDELINES FOR RIPARIAN FORESTS

By Robert Pfister and Kim Sherwood

BACKGROUND

This study was initiated as a 1987 McIntire-Stennis/Montana Riparian Association cooperative study (funded in May 1988) to develop management guidelines for riparian/wetland forests of Montana. This originally included three sub-objectives:

1. State-of-knowledge summary of recommended management practices relative to different sites, based on existing guidelines, experience and expert opinion.
2. Updating and refinement of forested riparian habitat types.
3. Evaluation of guidelines against recent silvicultural/ management prescriptions.

Experienced professionals from several disciplines were invited to join a Management Guidelines Working Group in 1988 to help plan details of the study At the first meeting we compiled a bibliography of pertinent references and a list of important variables. We agreed to focus initial attention on timber management practices relative to habitat types and physical site classifications and to structure a Delphi approach to seek consensus on expert opinions relative to management guidelines.

Three linkages to other current studies were established during 1988 which redirected some aspects of this study:

1. Involvement in the Montana Environmental Quality Council (EQC)/Best Management Practices (BMP) study in order to complement their group activities on general, consensus Best Management Practices (BMP's) to meet 319 Water Quality Regulations.
2. Cooperation with another McIntire-Stennis study on watershed risk assessment (D. Potts and K. Lull). The Oregon 208 risk assessment procedures used an expert opinion summary approach for evaluating relative risk of natural surfaces with a variety of management practices. We felt that a consensus on risk, relative to site types, would also be useful prior to attempting to reach consensus on management practices relative to site types. With a working group of experts already assembled for this study, we asked them to assist in a Delphi risk assessment exercise that could be used as part of both studies.
3. As the Flathead Basin Cooperative Study was being organized, we proposed carrying out our original objective 3 in the Flathead Basin and also to link this study to the BMP Site Audit study (Potts and Ehinger) for field efficiency and the opportunity to obtain broader input from the audit teams.

The Management Guidelines Working Group met again in August 1988 to review revised procedures. The Group agreed to concentrate current efforts on the risk assessment process using both a soil/slope and a habitat type classification. A survey structure to obtain opinions from working group members was designed and mailed to participants in February 1989.

A Working Group meeting was held in March 1989 to review and discuss the results and problems encountered in the Delphi exercise. Several problems with the original approach were discussed at this meeting, requiring modification of the matrices and clarifying the instructions for round two of the Delphi process. Only half of the members had sufficient habitat type familiarity and experience to contribute to the habitat type matrix risk assessment process. Furthermore, the habitat type matrix was not looking nearly as promising for evaluating the risk of soil erosion as the soil/slope matrix. We also decided that original objective 1 might be met more efficiently by reviewing published management implications for habitat types (Pfister and others 1977) in the field with another group of experts--the BMP audit teams. Work on the risk assessment was deferred until September 1989 because of the impending field season.

At the March meeting we also discussed the pressing need to develop criteria for field delineation of Streamside Management Zones (SMZ). The Montana Division of Forestry (1988) had published formulas for SMZ's and other agencies had their own criteria. With the development of draft State BMP's we saw the need for consideration of a new formula that could be evaluated during the proposed field work for the summer. On July 5, 1989, we proposed four points regarding definition of wetlands and recommended widths of Streamside Management Zones to Gary Brown, State Forester, for discussion at the BMP Technical Committee meeting on July 14, 1989 (Appendix A). As a result, the Management Guidelines Working Group of the Montana Riparian Association was requested to proceed with the development of SMZ criteria for possible later incorporation into the State BMP's

This study had changed directions significantly by this time. In preparation for a poster session at the Headwaters Hydrology Symposium, we re-evaluated structure and plans (Pfister and others 1989). Fortunately we had the flexibility to modify procedures to optimize cooperative opportunities with several concurrent efforts. The members of the Working Group also had a hand in directing the study efforts. The diagram in figure 1 illustrates several of the linkages that evolved.

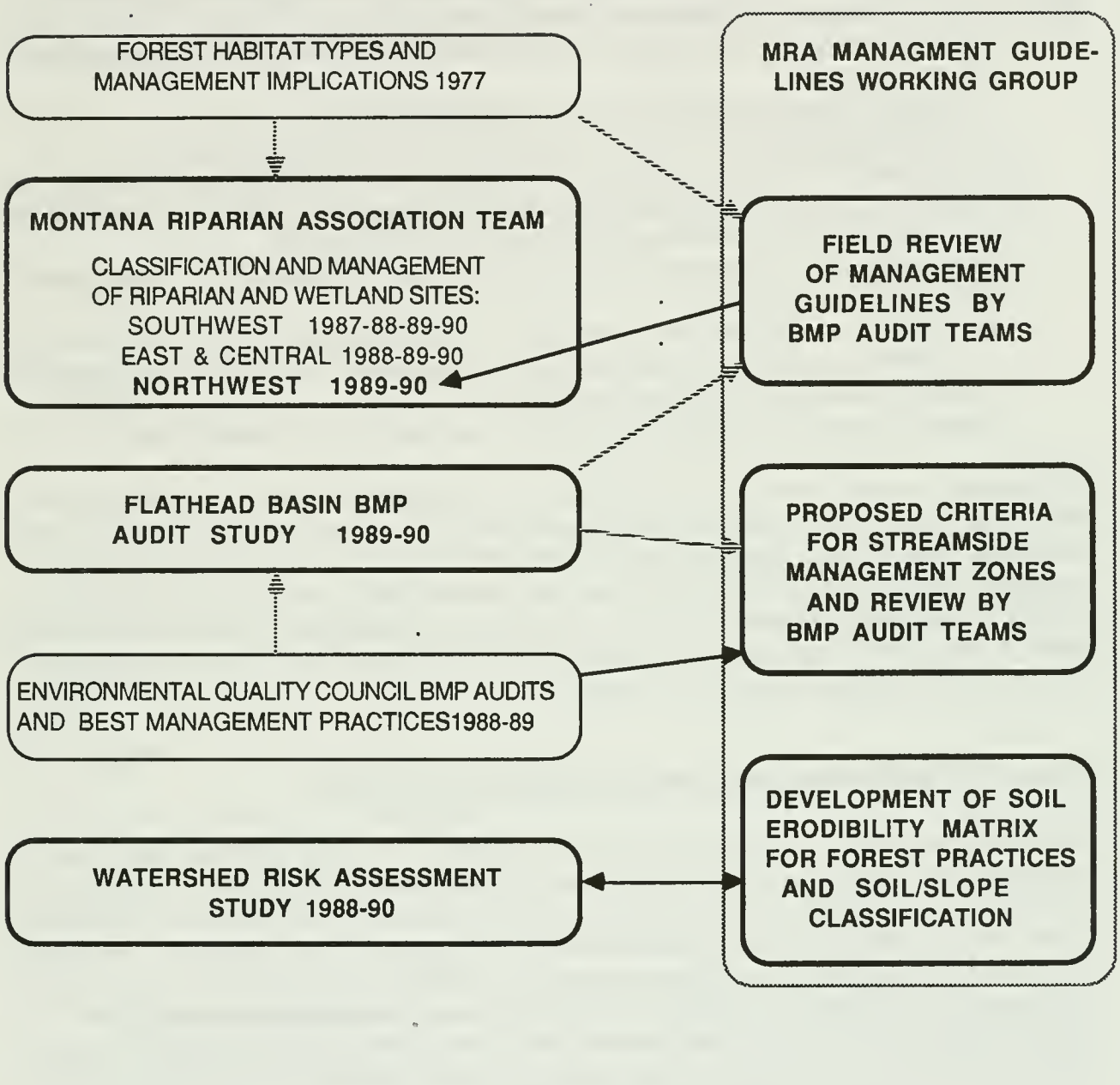
FOREST HABITAT TYPES AND MANAGEMENT IMPLICATIONS 1977
MONTANA RIPARIAN ASSOCIATION TEAM
CLASSIFICATION AND MANAGEMENT OF RIPARIAN AND WETLAND SITES:
SOUTHWEST 1987-88-89-90
EAST & CENTRAL 1988-89-90
NORTHWEST 1989-90
FLATHEAD BASIN BMP AUDIT STUDY 1989-90
ENVIRONMENTAL QUALITY COUNCIL BMP AUDITS AND BEST MANAGEMENT PRACTICES1988-89
WATERSHED RISK ASSESSMENT STUDY 1988-90
MRA MANAGMENT GUIDE-LINES WORKING GROUP
FIELD REVIEW OF MANAGEMENT GUIDELINES BY BMP AUDIT TEAMS
PROPOSED CRITERIA FOR STREAMSIDE MANAGEMENT ZONES AND REVIEW BY BMP AUDIT TEAMS
DEVELOPMENT OF SOIL ERODIBILITY MATRIX FOR FOREST PRACTICES AND SOIL/SLOPE CLASSIFICATION

Figure 1. Linkages in the Management Guidelines study. Areas in bold type are directly related to the Flathead Basin Cooperative Study effort.

REVISED OBJECTIVES OF THIS STUDY--JULY 1989

Based on discussions with the Working Group and developments in other studies, the objectives of this study were revised to:

1. Review and revise management information for forest riparian/wetland habitat types by:
   a. Field review by Flathead Basin BMP audit teams,
   b. Incorporate field review comments with current revision of classification and management information by K.Boggs and others, and
   c. Review of management information in Boggs and others (1990) by the Management Guidelines Working Group members.
2. Develop criteria for consistent and effective designation of Streamside Management Zones by:
   a. field review of proposed criteria by Flathead Basin BMP audit teams,
   b. review of criteria by Management Guidelines Working Group members.
3. Develop an expert opinion consensus of relative soil erosion risks of various forestry practices in relation to a soil/slope classification.

Objectives 1a and 2a are directly related to the Flathead Basin Cooperative Study and were conducted in conjunction with the Flathead Basin BMP audits. Objective 3 provided an essential tool for conduct of the Watershed Risk Assessment study. Separate publications dealing with each objective from a broader perspective than the Flathead Basin are already completed or in review draft form. This contract report covers the entire package, with appropriate references to other reports for details.

FIELD PROCEDURES--FLATHEAD BASIN AUDIT SITES

With the approval of Don Potts and Bill Ehinger, we assigned Kim Sherwood to accompany the BMP audit teams in order to obtain suggestions for revision of management information on as many sites as possible. On each site, the habitat types were identified by Kim Sherwood who then read the pertinent published management implications (Pfister and others 1977) to the BMP audit team. The team then provided feedback on the existing information relative to observations in that unit. The results were then summarized by habitat types and later incorporated into the new riparian and wetland classification for northwest Montana (Boggs and others 1990).

A second addition to the field audit procedures was to ask the BMP audit team if proposed criteria for determining width of the Streamside Management Zone would have been appropriate for the site. The proposed criteria were 1) 25 foot minimum, 2) include adjacent wetland, and 3) use soil/slope formula (Appendix A).

RESULTS--MANAGEMENT INFORMATION FOR HABITAT TYPES

Previously defined forest habitat types (Pfister and others 1977) in the Streamside Management Zone (SMZ) were recorded for 48 BMP audit sites. A summary of the habitat types observed and suggestions is shown in table 1.

Table 1. Habitat types observed on two or more of the BMP audit sites.

HABITAT TYPE ABBREVIATION	PHASE ABBREV.	WETLAND?	OBSERVED	DISCUSSED.	MGMT. O.K.	REVISION NEEDED
ABGR/CLUN	ARNU	No	3	2	2	0
ABGR/CLUN	CLUN	No	2	1	1	0
ABLA/CACA	--	Yes	3	2	0	2
ABLA/CLUN	ARNU	Variable	13	7	5	2
ABLA/CLUN	CLUN	Variable	5	3	2	1
ABLA/LUHI	MEFE	Variable	2	2	0	2
ABLA/OPHO	--	Yes	6	4	0	4
PICEA/CLUN	CLUN	Variable	9	4	2	2
PICEA/EQAR	--	Yes	8	3	2	1
THPL/CLUN	ARNU	Variable	6	4	4	0
THPL/OPHO	--	Yes	3	2	1	1

Nine habitat types were observed where management information was discussed by the audit teams on at at least two sites. Summaries of individual comments were made for each habitat type (Appendix B). These were provided to the classification team for incorporation with all other sources of information in the management information sections of the new wetland/riparian classification of northwestern Montana (Boggs and others 1990). For four of the types, the Flathead management information was simply added to previous information. (An example of the ABLA/OPHO habitat type revision is shown in Appendix C) However, most of the CLUN types were revised in the new classification to split off the wet end of the types; comments were incorporated into the new management information sections of the new types. One type (ABLA/LUHI,MEFE) illustrated the difficulty of getting to a wetland condition by using the 1977 key. The wetland sites within the upper subalpine would likely key to the new ABILAS/STRAMP in Boggs and others

(1990). For most of the types, the suggested changes were for added information rather than extensive changes. Discussions also revealed that some organizations use the existing habitat type management information much less than others.

Those types previously listed (Appendix A) as wetlands (ABLA/CACA, ABLA/OPHO, PICEA/EQAR, and THPL/OPHO) were confirmed to be obvious wetlands by the field observations in all areas (table 1). The other types in table 1 with the word "variable" indicated were observed to include both wetland and non-wetland conditions within them. Two interpretations are made for this observation. First, these types may need revision to more clearly separate them for wetland characteristics; most of this has been accomplished in the new classification (Boggs and others 1990). The second interpretation is that transitional types in bottomland situations often are found in a mosaic pattern with wetland pockets or stringers reflecting microsites of slightly lower elevations. This cannot be handled by revising the taxonomic classification. Rather, it requires the field person to determine the pattern of types present within a management unit and design the activities to protect the aquatic resources.

Although the management information gathered on the individual sites was summarized for application on a habitat type-specific basis (Boggs and others 1990), some concerns were discussed that apply to more general situations. These include headwaters management priorities, windthrow problems, stream protection, and regeneration practices.

Watershed concerns must be a top priority of management in headwaters areas (e.g. ABLA/CACA, and other wetlands within ABLA/LUHI, MEFE types) when considering activities such as timber harvesting and road building. The higher precipitation and snowpack of upper elevation headwaters require special attention to protect water quality. Although the streams may be very small, or intermittent, they require at least the same amount of protection regarding sediment production and transport as larger streams. For basins with a high density of small streams this may require treatment of entire units with the same care exercised in wetlands along streams at lower elevations.

Windthrow is an obvious problem in most wetlands and along streams. Some of the timber sales audited were actually set up to salvage previous blowdown. Blowdown (actual or potential) was specifically identified as a concern on 13 of the 48 sites. Large trees on wetland sites usually have shallow root systems and the soil has little holding strength when water tables are high. An undisturbed stand of large trees along the stream adjacent to cutting units is very susceptible to blowdown, creating unusually high amounts of woody debris in the stream and increased soil erosion potential and streambank damage from upturned root systems. Abrupt edges of different stand structures should be avoided. Windthrow risk can be reduced by several techniques, considered in combination with other objectives. Clearcutting removes the potential of

windthrow from the immediate site and transfers the problem to adjacent stands. Where clearcutting is used to meet other objectives, a treatment of adjacent stands (or salvage of expected blowdown) should be planned. Light partial cutting (removing less than 30 percent of the basal area) has been suggested for wetland sites. This can be accomplished with single tree or group selection harvesting, depending on the species composition and structure of the stands. One of repeated suggestions from the audit teams was to consider the selection of trees for removal that were the most susceptible to windthrow. Another suggestion was to use partial cutting, leaving windfirm trees on adjacent upland sites, to buffer the effects of wind on trees in the Streamside Management Zone. Local experience is especially valuable for interpreting windthrow risks. General prescriptions for Streamside Management Zones are not the answer. Rather, we recommend that windthrow risks and appropriate management of those risks be addressed specifically in a silvicultural prescription prior to harvesting activities.

Woody debris has been recognized as an essential component of stream structure in several kinds of streams. Potts and Anderson (1990) report on the importance of natural and logging woody debris in small stream channels. Some organizations are developing fairly rigid criteria for the leaving of trees along the stream for future woody debris recruitment. However, the potential of post-treatment blowdown may negate the objective of providing for long-term recruitment. The suggestion of selective harvesting of some of the high windthrow risk trees and leaving trees of various sizes that are more windfirm should be considered (as above). Again, we caution against generalized prescriptions. Rather, we recommend that woody debris recruitment be addressed specifically in a silvicultural prescription prior to harvesting activities. Work is also needed to define desired kinds, amounts, and timing of woody debris for different kinds of streams. Furthermore, the prescription for a specific site must be done in conjunction with knowledge of conditions upstream and downstream--a riparian ecosystem perspective. Potts and Anderson (1990) recommend a pre-disturbance appraisal to help define specific prescriptions.

Site preparation and successful regeneration are a major concern in streamside areas. Competition from grasses and shrubs often precludes conifer regeneration unless site preparation and regeneration are carefully planned. Hand scalping and planting is usually suggested for SMZs, but this may not be adequate site preparation to ensure regeneration success because of the heavy competition on wetland sites. Equipment usage is generally precluded in the current Best Management Practices. This may lead to general development of non-regenerated conditions which may not meet the desired future condition. Many examples of non-stocked areas in wetlands exist due to inadequate site preparation and/or grazing. A window of opportunity for site preparation may be needed to ensure regeneration and to mimic natural plant community succession. For mechanical or burning practices, this may be only a few weeks in late summer when the water tables are at the lowest level. If water tables rise following timber harvesting (as has been observed in several wetland sites),

then site preparation may need to be delayed a few years until regrowth is sufficient to lower the water table again. With present lack of predictability, monitoring may be the most efficient process to adjust timing of site-preparation and regeneration treatments to ensure meeting objectives.

Other relationships among habitat types were observed during the study that are helpful in understanding their distribution relative to site factors. One relationship was to document the relative sequence of types encountered moving away from open water for those sites where the data were available. These are summarized in table 2. (The distribution of these types is also related to a temperature (elevation) gradient that is generally arranged from cold to warmer in the left hand column.)

Table 2 - Adjacency relationships of wetland and transitional habitat types.

HABITAT TYPE	DRIER HABITAT TYPE	NO. OBS.
A. WETLAND TYPES		
ABLA/CACA	ABLA/CLUN, ARNU	1
	ABLA/CLUN, CLUN	1
ABLA/OPHO	ABLA/CLUN, ARNU	6
	ABGR/CLUN, ARNU	1
THPL/OPHO	THPL/CLUN, ARNU	3
PICEA/EQAR	PICEA/CLUN, CLUN	3
	ABLA/CLUN, ARNU	1
	ABGR/CLUN, ARNU	1
B. TRANSITIONAL TYPES		
ABLA/CLUN, ARNU	ABLA/CLUN, other	6
	ABLA/VACA	1
THPL/CLUN, ARNU	THPL/CLUN, CLUN	1
	ABGR/CLUN, ARNU	2
ABGR/CLUN, ARNU	ABGR/CLUN, other	2

The summary of adjacency relationships confirmed earlier placements of habitat types into "wetland" and "transitional" categories for the most part. It also illustrated that the types are found in fairly predictable sequences on local sites. For example, if ABLA/OPHO is the wettest condition on a site, the adjacent type would typically be ABLA/CLUN, ARNU, and the next driest type would typically be ABLA/CLUN, other phases. This information contributes to a more thorough description of adjacency relationships of each type in (Boggs

and others 1990) that will also be used in the future to arrange types along moisture and other gradients.

A summary of distribution of types was also made relative to four kinds of topography: 1) V-shaped valleys, 2) broader valleys with benches at short or 3) longer distances from the stream, and 4) very wide valleys with braided streams. Only four of the 48 sites were in V-shaped valleys; the remainder were in wider valleys and the distribution of habitat types was not obviously related to the categories used.

RESULTS--STREAMSIDE MANAGEMENT ZONES

The proposed criteria in Appendix A were the starting point for evaluation. Four habitat types (Pfister and others 1977) had been proposed as "wetland" and several other types or phases as "transitional". As discussed previously (see Table 1), the BMP audits confirmed this categorization. However, classification revision during 1989 and 1990 has provided an expanded list of "wetland" types for northwestern Montana (Boggs and others 1990). Field identification of the following "wetland" habitat types should meet the intent and definitions of the Best Management Practices for including adjacent wetlands within the Streamside Management Zone:

Abies lasiocarpa/Calamagrostis canadensis h.t (Subalpine fir/Bluejoint)
Abies lasiocarpa/Oplopanax horridum h.t. (Subalpine fir/Devils club)
Abies lasiocarpa/Streptopus amplexifolius, h.t., *Ligusticum canbyii* phase (Subalpine fir/Twisted stalk h.t., Canby's licorice-root phase)
Picea /Calamagrostis canadensis c.t. (Spruce/Bluejoint)
Picea/Cornus stolonifera h.t. (Spruce/Red-Osier dogwood)
Picea/Equisetum arvense h.t. (Spruce/Horsetail)
Picea/Lysichticum americanum h.t. (Spruce/Skunk cabbage)
Thuja plicata/Oplopanax horridum (Western redcedar/Devils club)
Thuja plicata/Athyrium filix-femina (Western redcedar/Lady fern)

Several other forest types are included in the riparian site classification, but are interpreted as being "transitional" between "wetland" and "upland" conditions. (for example, *Abies lasiocarpa/Ledum glandulosum* h.t.) At this time we have insufficient data to recommend requiring inclusion within the SMZ. However, examination of local soil and water table situations may suggest including part or all of some transitional types within the Streamside Management Zone.

The following expanded width guidelines for SMZs were proposed in June, 1989:

"Calculate SMZ for each side of stream from bank or average high water mark based on the following formula: SMZ (one side) = % slope X 100 X erodibility factor". (This formula is shown in a tabular form in Table 3.)

Table 3. Streamside Management Zone widths for various soil and slope classes.

Soil Erodibility Class	Slope (%) 10	20	30	40
	SMZ Width (feet)			
LOW (%Slope X 100 X 2)	50*	50*	60	80
MEDIUM (%Slope X 100 X 3)	50*	60	90	120
HIGH (%Slope X 100 X 4)	50*	80	120	160

* Based on 50 foot minimum.

To estimate soil erodibility classes we started with the standard used in the Forest Service's Northern Region and Intermountain Region (R1-R4) Sediment Yield Model. Soil erodibility based on parent materials (Cline and others 1981) is shown in Table 4.

Table 4. Soil erodibility based on parent material types (Cline and others 1981).

CATEGORIES	GEOLOGIC EROSION FACTOR
Highly Erodible	
Acid Igneous (Granitics)	1.00
Alluvium	1.05
Moderately Erodible	
Schist	.75
Soft Sediments	.66
Hard Sediments	.52
Slightly Erodible	
Basic Igneous	.42
Metamorphics (Belt Series)	.39
Serpentine	.35

These proposed guides were then reviewed in conjunction with the Flathead Basin BMP audits on 48 sites in 1989. On each site, the field audit teams were asked to evaluate the proposed slope/soil erodibility formula. The field teams encountered numerous problems in application of the proposed criteria:

	Number of Sites
Formula application worked well	20
Topographic breaks worked better than formula	20
Minimum of 25 feet judged inadequate	8
Adjacent wetlands was controlling criteria	5
Dry Draws - SMZ not critical	3

Most problems centered on trying to use a simplistic formula that did not include natural topographic breaks. There were also some questions raised on how the formula should be used when wetlands were part of the distance from the streambank. Based on this feedback, we developed a set of illustrations representing a range of field situations. We also developed a decision tree to help field personnel determine the order in which to apply the recommended criteria in a consistent fashion. This decision tree is illustrated in Figure 2.

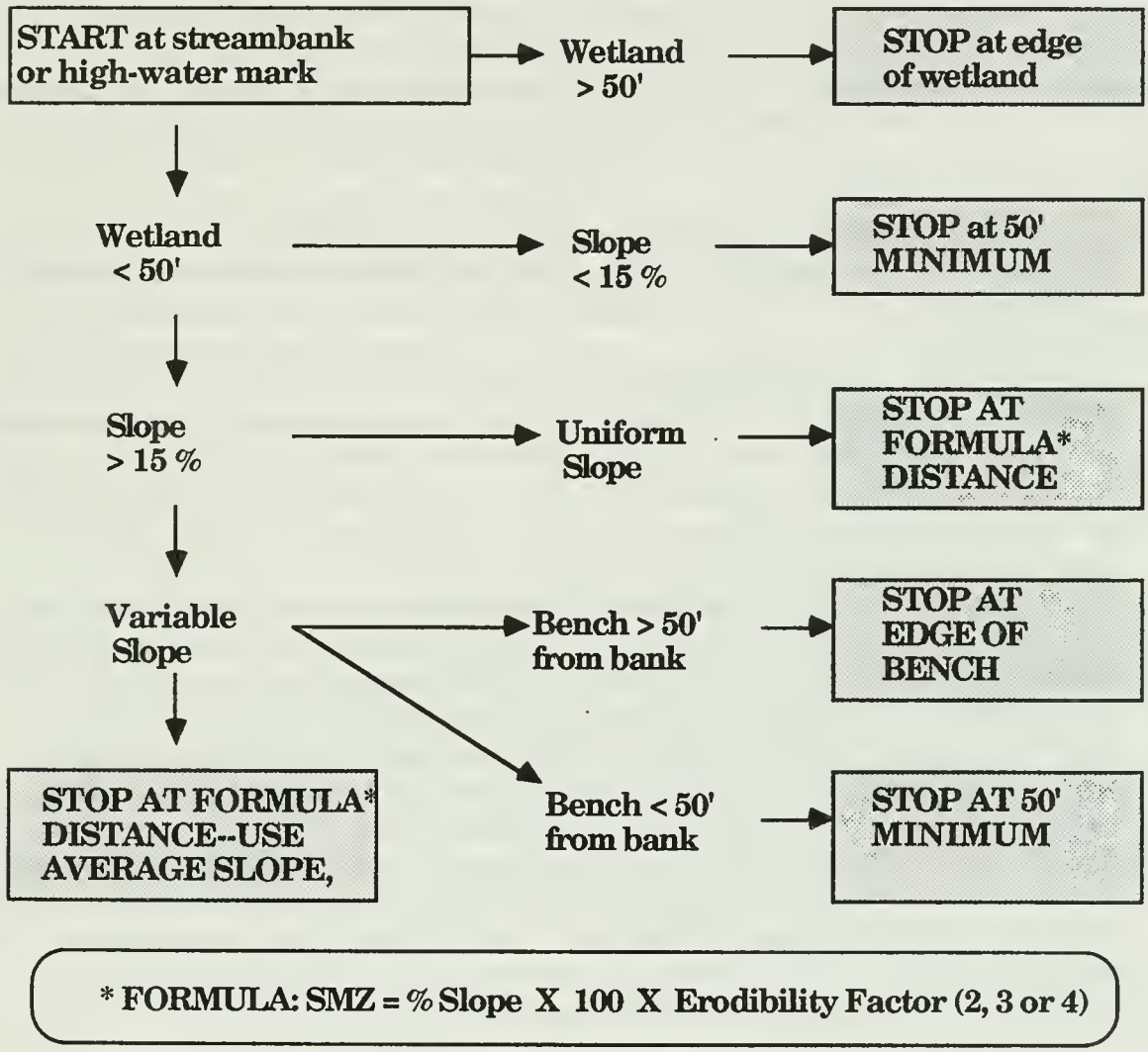
START at streambank or high-water mark
Wetland > 50'
STOP at edge of wetland
Wetland < 50'
Slope < 15 %
STOP at 50' MINIMUM
Slope > 15 %
Uniform Slope
STOP AT FORMULA* DISTANCE
Variable Slope
Bench > 50' from bank
STOP AT EDGE OF BENCH
STOP AT FORMULA* DISTANCE--USE AVERAGE SLOPE,
Bench < 50' from bank
STOP AT 50' MINIMUM
* FORMULA: SMZ = % Slope X 100 X Erodibility Factor (2, 3 or 4)

Figure 2. Field guide for locating edges of the Streamside Management Zone.

The decision tree (figure 2) has been reviewed by the Management Guidelines Working Group and field tested on a current Kootenai National Forest mapping project. Careful use of the process will allow practical use of natural topographic features and consideration of adjacent wetlands to meet the minimum standards of the current Best Management Practices (Environmental Quality Council 1989).

Variability of field conditions will still require professional judgement in delineating the SMZ. Wetlands often occur as pockets or stringers reflecting microsites in bottomlands. Wetlands may also extend up adjacent slopes reflecting unstable conditions. Microtopography also changes within management units. The decision tree process allows for varying the SMZ within the unit to provide stream protection. This needs to be balanced with other management considerations as long as the minimums at any one point along the stream are not violated.

The user should remember that the above criteria are to meet minimum standards and that the current BMP's allow considerable flexibility in management practices within the Streamside Management Zones. In order to ensure protecting water quality, the BMP Audit Teams and the Management Guidelines Working Group made several suggestions that should be considered in any specific operation:

1. If the existing stand has little woody debris and little undergrowth vegetation to trap and filter sediments, the SMZ should be expanded appropriately to provide an effective filter or use other mitigating measures.
2. Large trees in or near wetlands are especially susceptible to windthrow. Potential windthrow should be anticipated and planned for to minimize soil disturbance and bank damage caused by uprooted trees. This may mean removal of some high risk trees and/or minimizing edge effects of certain harvesting practices.
3. Trees should be marked and reserved along those stream segments where woody debris recruitment is needed for stream protection and fisheries habitat. The selection of reserve trees must be integrated with stream type, existing woody debris, windthrow risk, silvicultural prescription, harvesting practice, and projected stand development.
4. A sediment filter buffer may be needed *adjacent to certain wetlands* where routed sediments from roads or skid trails have a potential of being deposited in the adjacent wetlands.
5. Headwater basin sites may have a pattern of many small streams where it is complicated to define SMZ's for each tiny intermittent stream. However, these sites are critical in terms of watershed management. In many situations, it may be least controversial to simply treat entire cutting units as a Streamside Management Zone.

One of the first steps to ensure protection of water quality is to recognize and delineate the SMZ and make sure every person involved in a forestry operation knows where the boundaries are. The next step is to make sure the SMZ is not violated inadvertently during logging, slash disposal, or site preparation. It does little good to develop a sound prescription and conduct careful logging if the operator piling slash or the people conducting prescribed burning do not use the same care.

Estimating soil erodibility potential has been done in different ways and the Management Guidelines Working Group considered alternatives such as soil texture. Current studies are underway to obtain better estimators, but are not yet available for routine application. Until better estimates are available, we decided to stay with the original estimators. When better estimates become available (or local expertise is well documented) they can simply be substituted to place soils in one of the three classes.

The practical guidelines for delineating Streamside Management Zones are based on current knowledge. As additional knowledge is gained from current studies and experience, SMZ criteria and BMP's should both be modified to provide a proper balance between protection of water quality and efficiently meeting objectives of the landowners.

A 25-foot minimum SMZ was originally recommended by the Environmental Quality Council's Best Management Practices committee. The Montana Riparian Association Management Guidelines Working Group discussed the minimum at their final meeting in March, 1991. After weighing the minor advantages and disadvantages of 25 feet vs. 50 feet, they agreed to recommend a 50 foot minimum as a reasonable compromise in the context of current BMP's within the Streamside Management Zone.

RESULTS--SOIL ERODIBILITY MATRIX FOR RISK ASSESSMENT

The results of a group expert opinion consensus process (Delphi approach) to develop the soil/slope risk assessment matrix are summarized as Chapter One of Lull's Masters thesis (Lull, 1990). Lull also summarized literature on various ways to utilize the basic Delphi approach and provided good recommendations on how to complete the process of attempting to reach consensus and what to do if it doesn't happen. The round two matrix was also used as an aid in conducting the 1990 state-wide BMP field audits (Schultz 1990). The Working Group revised the matrix to obtain internal consistency at their meeting on March 6, 1991. This revised matrix is shown in Figure 3

MONTANA "RISK" MATRIX (3/91)

TYPE		CLEARCUT				PARTIAL CUT				SITE PREP			ROADS	
SLOPE	SOIL EROD.	TRACKED EQUIP.	RUBBER SKID	PARTIAL SUSP.	FULL SUSP.	TRACKED EQUIP.	RUBBER SKID	PARTIAL SUSP.	FULL SUSP.	MACHINE PILE/SCAR	BRDCAST BURN	OTHER	PERM.	TEMP.
0-5%	H	2	2	2	1	2**	2**	1	1	2	1	1	2**	3
	M	2	1	1	1**	2	1**	1	1	2**	1	1	1	1
	L	1	1	1	1	1	1	1	1	1	1	1	1	1
5-20%	H	4	3	2	1	4*	3	2	1	4	2	1	3	4
	M	3	2	1	1	3*	2	1	1	3	2	1	2	3
	L	2	2	1	1	2*	2*	1	1	2	1	1	2	2
20-40%	H	5	5	4*	2	5*	5*	3**	1	5	3**	1	4	5
	M	4*	4	3	1	3	3	2	1	4	3	1	3	4*
	L	3*	2	2	1	2	2	2	1	3	2	1	3*	3
> 40%	H	5	5	4	2	5	5	4	2	5	4	1	5	5
	M	5	5	4	2*	5	5	3	1	5	4	1	5	5
	L	4	4	3	1	4	4	2	1	4	3*	1	4	4

(* Indicates Mean Value Used, ** Final Group Consensus Adjustment for Internal Consistency)

Figure 3. The soil erosion risk matrix developed for use in the watershed risk assessment study as revised by the Working Group on March 6, 1991.

The Management Guidelines Working Group considered several alternatives to the parent material classes of Cline and others (1981) for estimating soil erodibility class. Fairly close agreement was reached on soil texture in the round two Delphi questionaire. However, current research by Ed Burroughs (USDA-Forest Service-Intermountain Station, Moscow, ID) suggests that the amount and shape of coarse fragments may be equally important. Also, USDA-Northern Region Soil Scientists are currently working on revised information on soil erodibility for input into improved sediment models. The Working Group decided (August 6, 1990) to defer further work on soil erodibility and wait for results of concurrent efforts. When better estimates of soil erodibility become available they can simply be substituted to place soils in one of our three classes. We think it is important to keep the methods for estimating soil erodibility consistent for risk assessment, streamside management zone formulas, and sediment models.

In the second-round Delphi exercise we asked the Working Group to respond to a suggestion of adjusting the risks proportional to annual precipitation zones. The Working Group rejected this suggestion on the basis that total precipitation may not be as important as other rainfall variables in predicting erosion probabilities.

The second round matrix using habitat types and practices was only completed by a portion of the expert opinion group. We do not plan any further work on that matrix because: 1)habitat types appear of less application to the questions of erosion than the soil/slope matrix, 2) because the wetland types have been extensively revised, and 3) the fragility (risk) of wetland types will be recognized by including them within the Streamside Management Zone.

Additional information on use of the soil erodibility risk matrix will be presented in the Watershed Risk Assessment contract report by Don Potts.

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Larry Brown	Vito Ciliberti	Mike Enk	Paul Hansen
John Joy	John Mandzak	Greg Munther	Bill Putnam
Donald Potts	Gordon Sanders	Bill Schultz	Dean Sirucek
Dan Svoboda			

Appendix A

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MONTANA RIPARIAN ASSOCIATION
July 5, 1989

TO: Gary G. Brown, State Forester
FROM: Robert D. Pfister, Coordinator - MRA
SUBJECT: BMP TECHNICAL COMMITTEE MEETING - JULY 14, 1989

Four items have come to our attention during our current study and field visits, and I would like to see discussion of these points at the July 14th meeting.

1. The definition of "stream" is still of concern. Is any protection provided for those streams that do not qualify because they have a soil or organic material streambed?

2. We have a draft proposal for Streamside Management Zone (SMZ) width based on soil erodibility and slope that our Riparian Management Guidelines Working Group is currently reviewing:

Soil Erodibility Class		Slope (%)				
		5	10	20	30	40(-)
LOW	(slope X 2)	25*	25*	40	60	80
MED	(slope X 3)	25*	30	60	90	120
HIGH	(slope X 4)	25*	40	80	120	160

*based on minimum of 25 ft.

3. We have tested the definition of wetlands, ". . . support a prevalence of vegetation typically adapted for life in saturated soil conditions." against our own data bases and find that the following habitat types (Pfister et al. 1977) could be considered wetlands (have greater than 25% combined canopy coverage of hydrophytic vegetation and a high water table most of the year).

ABLA/CACA (all Phases) ABLA/OPHO PICEA/EQAR THPL/OPHO

The following habitat types and phases are more appropriately considered "moistlands" (have less than 15% combined canopy coverage of hydrophytic vegetation and high water table only in the spring).

ABLA/CLUN - ARNU THPL/CLUN - ARNU TSHE/CLUN - ARNU
ABGR/CLUN - ARNU ABLA/GATR PICEA/CLUN - CLUN
PICEA/GATR

4. Inclusion of all adjacent wetlands in SMZ may be too all-inclusive and overly restrictive. SMZ guidelines are focused on the stream, the banks and the buffer (filter). Wetlands may extend hundreds of feet from a stream and require special attention, but not all SMZ restrictions. Therefore, there's a need to consider the alternative of strengthening the BMP item on operating in wetlands (Final Report - HJR 49, 1988).

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Appendix B

1989 FLATHEAD BASIN SITE AUDITS--SUMMARY OF HABITAT TYPE FEEDBACK

[(xx)=page number in Pfister and others (1977); numbers refer to 10/10/89 list of individual comments]

ABGR/CLUN (67) (Not in Boggs and others 1990; some comments may apply to ABIGRA/SENTRI)

1,5 - This type often occurs on limestone soils with an ash-cap.

2 - Do not leave GF with Indian paint fungus as a seed source.

3 - It's important to reforest this type within 2-3 years because of competition with brush and GF.

4 - This type has some potential for seeps--use caution with road construction and drainage as well as equipment operation, especially following logging.

ABLA/CACA (88) (Comments incorporated in Boggs and others 1990)

1 - Site preparation discussion should include planting.

2,3 - Proper volume "level" of removal varies on a stand by stand basis; stand composition and/or basal area targets may be usable as criteria.

5,6,7 - High elevation sites may occur on silty loams. All things considered, these sites may be more of a "problem" than a "resource" from a timber management standpoint (because of water and regeneration concerns).

ABLA/CLUN (82) (Not in Boggs and others 1990; comments used for new ABILAS/STRAMP type)

2 - ARNU phase needs some discussion on site preparation--i.e. can heavy equipment be used on these soils?

3,6 - Active management of this type in the SMZ is particularly important because of high blowdown potential. Uneven-age management may be difficult in this type, but we should explore it as a possibility.

4 - The MEFE phase seems to be quite susceptible to blowdown.

5,8 - Several regeneration concerns:

a. Brush field development.
b. Considerable bare soil exposure required for WL and DF.
c. Good success with WL on seed tree cuts.

9 - Volcanic ash surface soils are common in the ARNU phase--important to maintain surface layer during site preparation.

ABLA/LUHI (108) (Not in Boggs and others 1990; comments may apply to upper elevations of the new ABILAS/STRAMP type)

1,2 - Although previously in the commercial timber base, some districts are removing it because this type seems better suited to watershed management concerns. Deep snowpack produces a lot of water that becomes difficult to contend with relative to timber management activities.

ABLA/OPHO (81) (Comments incorporated in Boggs and others 1990)

1,15 - These sites have higher productivity than indicated.

2,3,13 - Winter logging is a viable option--this type often occurs on porous soils; to "preclude equipment" is too restrictive.

7,8,11 - Riparian areas in this type are especially prone to blowdown problems. Active management may be more beneficial from a water quality standpoint than a "hands-off" approach. Even logging only one side leaves spruce susceptible to blowdown. "Consider removal of high-risk decadent trees to reduce risk of blowdown and promote uneven-age management and growth of younger, windfirm trees." (Collins - DSL)

4 - These sites seem to "heal" quickly following logging.

5 - Though a few places are "scenic", these sites are not really prime recreational sites.

6 - Because this type sometimes occurs on clay soils (either clay soils with high water-holding capacity or porous systems with a lot of subsurficial flow), possibilities and precautions should be discussed.

9,10 - Natural regeneration seems to be a problem, although planting larch following clearcutting seems to work well.

12 - Occurrence of seeps in Flathead and Swan expand the acreage of this type--more than just "stringers" (i.e. Coal Creek).

THPL/CLUN (71) (Not in Boggs and others 1990; comments used for new ATHFIL and STRAMP types)

1,2,4 - Regeneration problems - many sites (Swan) are overstocked; competition in seral stages is substantial. Site prep is necessary to promote seral species.

3 - Two soil conditions give rise to this type; some ARNU sites are actually well drained; there's just a lot of water moving through the soil.

5,6,7,12 - Streamside slopes are often gentle (0-15%) but there may be a problem with some activities at the edge of a 25 ft. buffer. In these situations, the nature of the stream will play a big role in SMZ layout.

8,9,11 - Some sites have very little understory vegetation (closed stands). This may reduce filtering capability, especially in "buffer strips". This is especially important because high probability of seeps in this type could be a problem for road construction and drainage failures. Also, this type may be susceptible to rises in the water table following logging.

10 - Potential for blowdown appears to be high in all the THPL types.

THPL/OPHO (73) (Need to add blowdown potential to Boggs and others 1990)

1 - There is more bare rock exposure than indicated.

2,3 - Though there are some areas of this type that are scenic attractions (Ross Creek Cedars), many closed stands (Swan) are "small diameter", high blowdown potential stands.

PICEA/EQAR (58) (Comments incorporated in Boggs and others 1990)

1,2 - There is more opportunity for management than indicated. Options winter logging, designated skid trails and winching should be discussed. Snow depths for winter logging should be > 24 inches.

PICEA/CLUN (59) (Not in Boggs and others 1990; comments may apply to new PICENG/CORSTO type)

1,6 - May encounter regeneration problems in this type, particularly with spruce and larch because of cold air drainage, especially after logging.

3,5,8,9 - This type often occurs on lacustrine soils--managers should be aware of this possibility and take necessary precautions, if applicable--compaction may be a problem, especially after logging (i.e. slash disposal and site preparation) large acreages of this type.

3,7 - There may be a possibility of an increased water table for _?_ years following logging.

Appendix C

The Abies lasiocarpa/ Oplopanax horridum h.t. (from Boggs and others 1990)

***Abies lasiocarpa/Oplopanax horridum* h. t.**
(Subalpine Fir/Devil' Club h. t.)

ABILAS/OPLHOR (ABLA/OPHO)
Number of stands sampled = 4

COMMENT — The discussion below represents an expanded description of this habitat type as defined by Pfister and others (1977).

LOCATION AND ASSOCIATED LANDFORMS
The *Abies lasiocarpa/Oplopanax horridum* (subalpine fir/devil's club) habitat type is an incidental type at mid-elevations. Sampled sites ranged in elevation from 1,200 -1,500 m (3,900-5,000 ft). This habitat type occurs on wet bottoms and sites near streams, springs, or seepage areas where the water table remains near the soil surface all year. Although normally restricted to wet bottoms and sites near streams and springs, the occurrence of seeps in some drainages, such as the Swan and Stillwater, effectively expands the acreage of this type considerably. It often forms narrow stringers along streams.

FLORISTIC CHARACTERISTICS OF LATE SERAL TO CLIMAX STANDS
Climax stands are codominated by *Abies lasiocarpa* (subalpine fir) and *Picea* (spruce). *Pseudotsuga menziesii* (Douglas fir), *Larix occidentalis* (western larch), and *Pinus monticola* (white pine) are scattered throughout the stands; *Thuja plicata* (western red cedar) and *Tsuga heterophylla* (western hemlock) may occur as sporadic accidentals. This habitat type often supports very large old growth trees. The undergrowth is dominated by *Oplopanax horridus* (devil's club), *Taxus brevifolia* (Pacific yew), *Clintonia uniflora* (queen's cup), *Tiarella trifoliata* (trefoil foamflower), *Athyrium filix-femina* (ladyfern), and *Gymnocarpium dryopteris* (oak-fern).

The following table gives the average percent average percent canopy cover and range of indicator species or those species with a 50% or more constancy (e.g., occurs in at least 50% of the stands sampled) in **late seral to climax stands:**

Species	% Canopy Cover Average	Range	Const.
TREES			
Abies lasiocarpa (subalpine fir)	30	15-45	100
Larix occidentalis (western larch)	12	0-25	50
Picea (spruce)	30	0-65	100
Pinus monticola (western white pine)	2	0-5	50
Pseudotsuga menziesii (Douglas fir)	12	0-25	50
SHRUBS			
Acer glabrum (Rocky Mountain maple)	11	0-25	100
Cornus stolonifera (red-osier dogwood)	1	0-1	50
Lonicera utahensis (Utah honeysuckle)	1	0-1	75
Menziesia ferruginea (fool's huckleberry)	10	0-25	50
Oplopanax horridum (devil's club)	40	15-65	100
Pachistima myrsinites (mountain-boxwood)	1	0-1	50
Ribes lacustre (swamp currant)	2	0-5	50
Rubus idaeus (red raspberry)	1	0-1	50
Rubus parviflorus (thimbleberry)	1	0-1	75
Symphoricarpos albus (common snowberry)	10	0-25	50
Taxus brevifolia (Pacific yew)	31	1-65	100
Vaccinium globulare (globe huckleberry)	1	0-5	75
GRAMINOIDS			
Bromus vulgaris (Columbia brome)	1	0-5	75
Carex gravida (heavy sedge)	1	0-1	25

FORBS			
Actaea rubra (baneberry)	1	1	100
Adenocaulon bicolor (trail-plant)	3	0-5	50
Aralia nudicaulis (wild sarsaparilla)	12	0-25	50
Arnica latifolia (broadleaf arnica)	9	0-25	75
Athyrium filix-femina (ladyfern)	20	1-45	100
Clintonia uniflora (queen's cup)	7	1-25	100
Disporum hookeri (hooker fairy-bell)	1	0-1	50
Galium triflorum (sweetscented bedstraw)	1	0-5	75
Goodyera oblongifolia (western rattlesnake-plantain)	1	0-1	50
Gymnocarpium dryopteris (oak-fern)	16	1-25	100
Hieracium albiflorum (white-flowered hawkweed)	1	0-1	50
Osmorhiza chilensis (mountain sweet-cicely)	1	0-1	75
Pyrola secunda (one-sided wintergreen)	1	0-1	50
Smilacina stellata (starry Solomon-plume)	7	1-25	100
Streptopus amplexifolius (clasping-leaved twisted stalk)	1	0-1	50
Thalictrum occidentale (western meadowrue)	1	1-5	100
Tiarella trifoliata (trefoil foamflower)	16	1-25	100
Trillium ovatum (white trillium)	1	0-1	50
Veratrum viride (green false hellebore)	1	0-1	75
Viola canadensis (Canada Violet)	2	1-5	75
Viola orbiculata (round-leaved violet)	2	1-5	100

SOILS

Parent materials were noncalcareous. The soils were non-gravelly loams and the surface soils were acid. Exposed rock and soil were not noted. Duff depths were 7-10 cm (3-4 in). The water table typically remain near the soil surface all year. Soil textures range from fine, poorly drained materials to coarse, well drained soils (Pfister and Sherwood 1989).

ADJACENT COMMUNITIES

Adjacent wetter sites support *Carex* (sedge) communities, and drier sites may include the *Abies lasiocarpa/Calamagrostis canadensis* (subalpine fir/bluejoint reedgrass) habitat type. The *Thuja plicata/Oplopanax horridum* (western red cedar/devil's club) habitat type occupies similar sites, except it is typically found at warmer, lower elevations.

MANAGEMENT INFORMATION

In addition to the information given below, the following information is summarized by species in Appendices 2-8: 1) forage palatability (cattle, sheep, and horses), 2) wetland status, 3) energy value, 4) protein value, 5) thermal or feeding cover values (elk, mule deer, whitetail deer, upland game birds, waterfowl, small non-game birds, and small mammals), 6) food value or degree of use (elk, mule deer, whitetail deer, antelope, upland game birds, waterfowl, small non-game birds, and small mammals), 7) potential biomass production, 8) erosion control potential, 9) short-term revegetation potential, and 10) long-term revegetation potential.

Livestock — Grazing potential is very low.

Timber — Timber productivity is moderate to high, but sites require careful attention and caution for intensive timber management. High water tables during most of the season may preclude the use of heavy equipment. Heavy equipment operation should be restricted to those times of year when soils are frozen and snow covered.

Proper riparian management needs to be seriously considered for the *Abies lasiocarpa/Oplopanax horridum* (subalpine fir/devil's club) habitat type. Shallow rooted species, fine textured soils, and high water tables contribute to a high degree of instability, especially following logging of adjacent stands. Logging only one side of a stream, sometimes effective in reducing blowdown, ***does not*** seem to substantially increase the ability of the Streamside Management Zone to remain intact. Heavy partial cutting or harvesting of adjacent stands by even-aged systems will accelerate windthrow of large trees, especially *Picea engelmannii* (Engelmann spruce), in residual stands. Removal of decadent, old growth

trees, leaving younger, wind resistant species often leaves the Streamside Management Zone in better condition to withstand winds following logging. However, this may directly conflict with some agency management objectives; if retention of old growth for fish (woody debris recruitment) and wildlife habitat (including nesting and roosting trees) is an objective, prescriptions must be designed to minimize blowdown or losses to water quality (fisheries habitat) may result (Pfister and Sherwood 1989). If large numbers of uprooted trees lead to water quality degradation, then removal may be appropriate. Silvicultural prescriptions must be clearly defined, objectives should be obtainable, and proposed treatments should be carefully evaluated against their chances for success.

These sites may need to be regenerated quickly to avoid losses to competing vegetation; recommended species are *Picea engelmannii* (Engelmann spruce), *Larix occidentalis* (western larch), and *Pseudotsuga menziesii* (Douglas fir). While natural regeneration of these sites is known to be a problem, in some parts of the Flathead National Forest, planting of *Larix occidentalis* (western larch) has been successful following clearcutting (Pfister and Sherwood 1989).

Wildlife — Forage productivity for deer and elk is probably low. This habitat type along with other moist old growth communities are rare in Montana. Many wildlife species, such as chestnut-backed chickadees and goshawks, are partially to strongly dependent on huge old growth trees for forage, cover, and nesting nesting sites.

Fire — Fires are rare on these sites due to the high water tables.

Soil Management and Rehabilitation Opportunities — Due to the high water tables, any development (road constructions, trails, site development, etc.) has a high potential for problems. Proposed timber management activities, especially road layout, design, and construction may require consultation with specialists (hydrologists, soil scientists, engineers, etc.) to minimize on-site and off-site impacts. Heavy equipment operation should be restricted to those times of year when soils are frozen and snow covered.

Recreational Uses and Considerations — Old growth stands with large diameter trees have high recreational and aesthetic values, but site development should take into account the difficulty of managing sites with high water tables.

OTHER CLASSIFICATION SYSTEMS

U.S. Fish and Wildlife Service Wetland Classification (Cowardin and others 1979) — SYSTEM Palustrine, CLASS Forested Wetland, SUBCLASS Needle-leaved Evergreen, WATER REGIME (NONTIDAL) Seasonally Flooded to Saturated.

OTHER STUDIES

Similar habitat types were described by Illingworth and Arlidge (1960) for eastern British Columbia and by Ogilvie (1962) for southwestern Alberta.

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